Does Liquidity Affect the Price Discovery Process in Credit Derivatives Markets? Emerging Scholars in Banking and Finance (Cass Business School)

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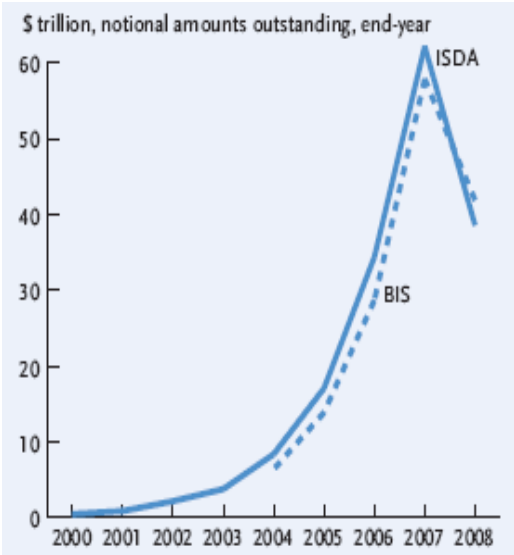
Introduction

- What is a CDS?
  - A CDS is an insurance contract which provides protection against credit risk until the occurrence of a credit event or the maturity date of the contract, whichever is first, in exchange for periodic premium payments (the CDS premium or CDS spread: $\bar{s}_t$).
  - The CDS contract that we analyze is unfunded and so, investors do not make an up-front payment.
- What is an asset swap package (ASP)?
  - An ASP contains a defaultable coupon bond and an interest-rate swap (IRS).
  - By means of the IRS the buyer of the ASP receives the **Euribor plus the asset swap spread** s^A and pays the **bond coupon**.
  - The value of the whole package is the par value of the defaultable bond.

Introduction

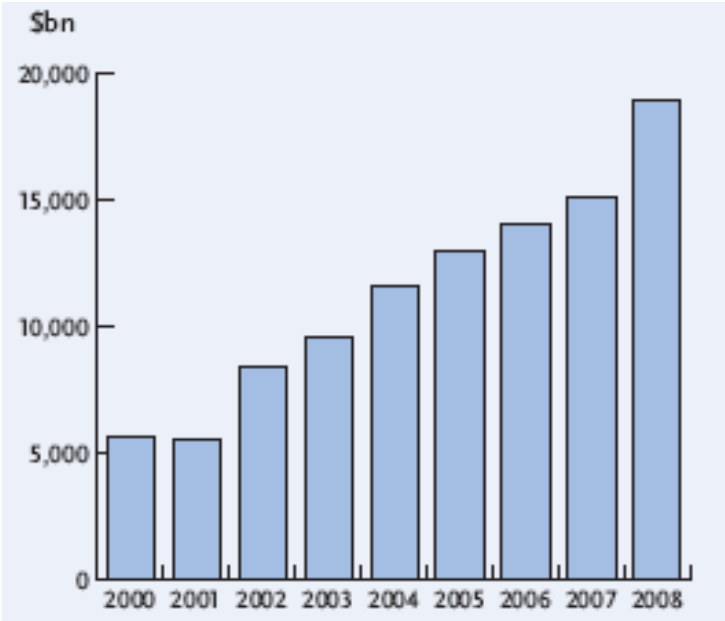
Credit Default Swaps and Bond Statistics

Credit Default Swaps Outstanding



Source: International Swaps and Derivatives Association (ISDA), Bank for International Settlements (BIS).

Bond Trading On Exchanges



Source: World Federation of Exchanges

- ISDA statistics reflect a 39% drop in notional amounts outstanding of CDS from $62tr at end-2007 to $38tr at end-2008.
- Bond trading on exchanges increased by a quarter in 2008 to over 19$tr.

Outline

Literature Review

- An efficient price discovery process is characterized by the fast adjustment of market prices from the old equilibrium to the new equilibrium with the arrival of new information (Yan and Zivot (2007)).
- Garbade and Silver (1983) (GS henceforth) offer a formal model to analyze the process of price discovery and show that this process is leaded by the markets where the number of participants is higher (more liquid).
- Most of the current price discovery analyses are based on either Hasbrouck (1995) or Gonzalo and Granger (1995) (GG henceforth) econometric methodologies.
- In one of these applications to the commodity markets, Figuerola-Ferretti and Gonzalo (2008) develop an econometric approach in order to match the theoretical model of GS and the econometric methodology of GG.

Literature Review

- The applications to credit derivatives markets analyze CDS and bond markets before the current crisis:
  - Blanco et al. (2005), Zhu (2006), Norden and Weber (2004) and Dötz (2007) among others obtain that CDS market reflects the information more accurately and quickly than bond market.
- Other stream of the literature studies the variations in the correlation between the CDS premias during the episode of Ford and GM downgrades (Acharya et al. (2007) and Coudert and Gex (2008)).
  - They find a significant increase in CDSs premiums correlations between firms during this episode.

Contribution

- We present a theoretical model to understand how the process of price discovery works in the credit markets.
- We analyze the price discovery process between ASPs, bonds and CDSs.
- We study the variations in the correlation between ASP, bond and CDS markets by means of a DCC-GARCH model.

Price Discovery Model

- The procedure is based on the behavior of market participants in the corresponding market place:
  1. Agents that only participate in the ASP market.
  2. Agents that only participate in CDS market either as protection sellers or buyers.
  3. Agents that participate in both financial markets as market makers.
  4. Agents using the CDSs to hedge their positions in corporate debt.
  5. Arbitrageurs who try to exploit possible discrepancies among CDS and ASP prices.
- We offer a more general model than in GS by including agents **3.** and **4.**

Price Discovery Model: Arbitrageur's demand

- A popular arbitrage strategy in credit derivatives defines the correct price from a long term equilibrium price based on the cointegration methodology:

$$s_t^A = \underbrace{\beta_2 \bar{s}_t + \beta_3}_{\text{Long-term price}} \tag{1}$$

- If the ASP spread is too high relative to the long-term equilibrium price, the strategy is:
  - **Portfolio I:** Long position in an ASP + Loan.
  - **Portfolio II:** Long position in a CDS.
  - Portfolio I + Portfolio II payments: $s_t^A - \bar{s}_t$.
- The demand of arbitrageurs will depend on the grade to which the equivalence relationship holds and on their elasticity of demand which is denoted as H:

$$H(\beta_2 \bar{s}_t + \beta_3 - s_t^A), \quad H > 0 \tag{2}$$

Price Discovery Model: Demand schedule of market participants

- The demand schedule for the j^{th} participant who deals only in ASP market is:

$$E_{j,t} - A^{ASP}(R_{j,t}^{ASP} - s_t^A), \quad A^{ASP} > 0, \quad j = 1, ...N_{ASP} \tag{3}$$

  - $E_{j,t}$ is the ASP endowment of the j^{th} participant immediately prior to period t.
  - $R_{j,t}^{ASP}$ is the reservation price at which participant j^{th} is willing to hold $E_{j,t}$.
  - $A^{ASP}(R_{j,t}^{ASP} - s_t^A)$ is the variation in the endowments prior to period t, $E_{j,t}$.
  - If $R_{j,t}^{ASP} < s_t^A$ the investor is a buyer of ASPs and vice-versa $\Longrightarrow E_{j,t+1} > E_{j,t}$.
    - The higher s_t^A the higher the ASP buyers' returns.

Price Discovery Model: Demand schedule of market participants

- The demand schedule for the participants who deal only in CDS market is:

$$E_{i,t} - A^{CDS}(\bar{s}_t - R^{CDS}_{i,t}), \quad A^{CDS} > 0, i = 1, ...N_{CDS} \tag{4}$$

  - If $\bar{s}_t > R^{CDS}_{i,t} \Longrightarrow$ net suppliers of CDSs (protection sellers) who find that at this price they are willing to sell protection and $E_{i,t} \downarrow$.
  - If $\bar{s}_t < R^{CDS}_{i_2,t} \Longrightarrow$ net demanders of CDSs (protection buyers) who find that at this price they are willing to buy protection and $E_{i,t} \uparrow$.

Price Discovery Model: Demand schedule of market participants

- Demand schedule of market makers in both the ASP and the CDS market:

$$E_{k,t}^{B,ASP} - A^{B,ASP}(R_{k,t}^{B,ASP} - s_t^A), \quad A^{B,ASP} > 0, k = 1, ...N_{BOTH} \tag{5}$$

$$E_{k,t}^{B,CDS} - A^{B,CDS}(\bar{s}_t - R_{k,t}^{B,CDS}), \quad A^{B,CDS} > 0, k = 1, ...N_{BOTH}$$

  - The demand is defined exclusively from the reservation price in the corresponding market.

- Demand schedule of hedgers:

$$E_{h,t}^{H,ASP} - A^{H,ASP}(R_{h,t}^{H,ASP} - s_t^A), \quad A^{H,ASP} > 0, h = 1, ...N_H \tag{6}$$

  - These agents are completely hedged and then, the demand of CDSs is equal to the demand of ASPs.

Price Discovery Model: Clearing market conditions

- The ASP market will clear at the value of s_t^A that solves the supply/demand equation:

$$\sum_{j=1}^{N_{ASP}} E_{j,t} + \sum_{k=1}^{N_{BOTH}} E_{k,t}^{B,ASP} + \sum_{k=1}^{N_H} E_{h,t}^{H,ASP} = \tag{8}$$

$$= \sum_{j=1}^{N_{ASP}} \left[E_{j,t} - A^{ASP}(R_{j,t}^{ASP} - s_t^A) \right] + \sum_{k=1}^{N_{BOTH}} \left[E_{k,t}^{B,ASP} - A^{B,ASP}(R_{k,t}^{B,ASP} - s_t^A) \right] +$$

$$+ \sum_{h=1}^{N_H} \left[E_{h,t}^{H,ASP} - A^{H,ASP}(R_{h,t}^{H,ASP} - s_t^A) \right] - H(\beta_2 \bar{s}_t + \beta_3 - s_t^A)$$

  - The CDS market will clear at the value of $\bar{s}_t$ that solves the equivalent supply/demand equation.
  - We solve the previous equations to find s_t^A and $\bar{s}_t$as a function of R_t^{ASP}, $R_t^{B,ASP}$, $R_t^{H,ASP}$, R_t^{CDS} and $R_t^{B,CDS}$.

Price Discovery Model: Finding the Equilibrium

- The mean reservation price in a given market X behaves according to:

$$R_t^X = s_{t-1}^X + v_t + w_t^X \tag{7}$$

  - $R_t - s_{t-1}$ reflects the arrival of new information between dates $t-1$ and t at market X.
  - v_t : Common white noise.
  - w_t : Market idiosyncratic white noise.

Price Discovery Model: Finding the Equilibrium

- Substituting and substituting ... we obtain the following VECM:

$$\Delta X_t = \alpha\beta' X_{t-1} + \sum_{i=1}^{p} \Gamma_i \Delta X_{t-i} + u_t \tag{8}$$

where $X_t = \left(s_t^A, \bar{s}_t\right)'$ and u_t is a vector white noise with $E(u_t) = 0$ and $Var(u_t) = \Omega > 0$.

$\alpha' = (\alpha_1, \alpha_2)$ represents the coefficients that determine the market contribution to price discovery.

Price Discovery Model: Finding the Equilibrium

- Using the GG permanent-transitory (PT) decomposition we obtain the GG price discovery metrics for both the ASPs and the CDSs:

$$GG_{ASP} = \frac{\alpha_2}{-\alpha_1 + \alpha_2} \text{ and } GG_{CDS} = \frac{-\alpha_1}{-\alpha_1 + \alpha_2} \tag{9}$$

$$GG_{ASP} = \frac{N_{BOTH} + N_{ASP}}{2N_{BOTH} + N_{ASP} + N_{CDS}} \text{ and } GG_{CDS} = \frac{N_{BOTH} + N_{CDS}}{2N_{BOTH} + N_{ASP} + N_{CDS}} \tag{10}$$

  - A given market leads the process of price discovery whenever its corresponding price discovery metric (GG_i *for* $i = ASP, CDS$) is higher than 0.5.
  - We consider that both markets reveal information in an equal efficient way whenever the price discovery metrics are close to 0.5 for both markets $(0.45, 0.55)$.

Data

- Daily data on Eurobonds and ASPs denominated in Euros which are obtained from Reuters.
- Daily data on CDSs denominated in Euros that are obtained from GFI:
  - Data contain actual trades.
- After filtering our dataset to include the most liquid bonds and dates we obtain a final sample: 38 non-financial companies and 50 ASPs and bonds.
- The data spans from November 1st, 2005 to 9th September 2008 but we split the data into two subperiods:
  1. November 1st, 2005 to July 15th, 2007.
  2. July 15th, 2007 to September 9th, 2008.

Hypotheses

- **Hypothesis 1:** In high liquid scenarios where N_{CDS} is high relative to N_{ASP} and/or N_{BOTH} is high $\Rightarrow$ **CDSs lead ASPs in the price discovery process and/or should reveal information as efficiently as the ASPs.**
  - Buy-and-hold strategy employed by the ASP or bond buyers.
  - CDS investors' active behavior.
- **Hypothesis 2:** In scenarios with high liquidity risk which reduces market participation $\Longrightarrow$ the position of ASPs as information providers should improve.
  - Market makers (price setters) face financial constraints that lead to $N_{BOTH} \downarrow\downarrow$ (Acharya and Schaefer (2006)).
  - Bonds handle much better market turbulences than CDSs (Dötz (2007)).
  - Increase in the bond trading vs. decrease in the CDSs outstanding.
- **Hypothesis 3:** The ASPs always reflect credit risk more efficiently than the bonds.
  - ASP markets can be even more liquid than bond markets (Schonbucher (2003)).

Price Discovery Results

- The analysis based on the VECM is possible whenever:
  - ASP, bond and CDS spreads are I(1): in 39 of 50 cases ✓.
  - ASP and CDS (bond and CDS) spreads that are I(1) are cointegrated: in 27 of 39 cases ✓.
  - ASP and bond spreads that are I(1) are cointegrated: in 39 of 39 cases ✓.
- Before the crisis:
  - CDS market is the most efficient market ($GG_{CDS} > 0.55$) in 19 of 27 cases.
  - In the remaining 8 cases the CDS market reveals information as efficiently as the ASP market ($0.45 \leq GG_{CDS} \leq 0.55$) $\Longrightarrow$Hypothesis 1✓.

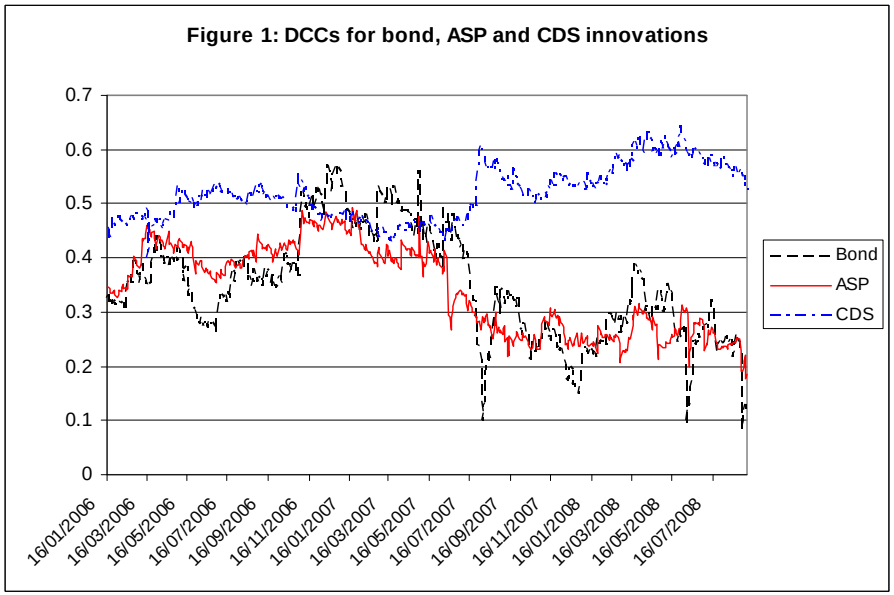
Price Discovery Results

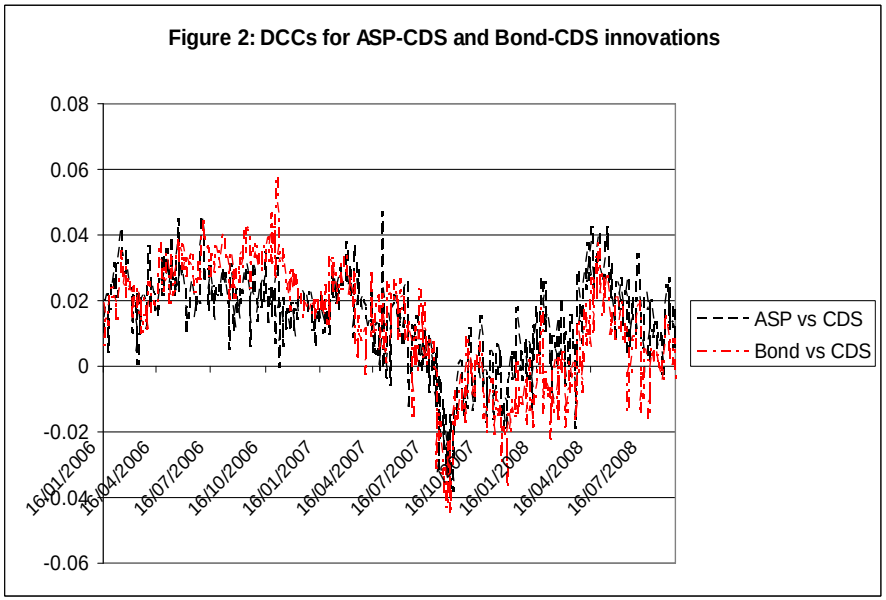
- During the Crisis
  - ASP is the most efficient market in 8 of 27 cases.
  - ASP spreads reveal more efficiently credit risk than before in 21 of 27 cases.
  - On average ASPs reveal credit risk much better than before the crisis ($GG_{ASP}^{after} = 0.395$ *vs* $GG_{ASP}^{before} = 0.261$) $\Longrightarrow$ Hypothesis 2 ✓.
- We repeat the analysis for bond and CDS spreads and obtain similar results.
- Comparing bond and ASP markets:
  - ASP market is more efficient in 37 of 39 cases in the first subperiod and in 36 of 39 cases in the second one$\Longrightarrow$Hypothesis 3 ✓.

Additional Results

- To analyze the credit spreads co-movement, we first isolate the component of credit spreads returns that is unrelated to changes in fundamentals and form pairs with these residuals/shocks.
- Then we analyze the dynamic correlations between the pairs of residuals by means of the DCC-GARCH model of Engle and Sheppard (2001) and Engle (2002):
  - Within markets: CDS, Bond and ASP.
  - Between markets: (CDS, ASP) and (CDS, bond).

Additional Results





- CDS market increased its internal integration while it decreased in the ASP and bond markets.
- There is an increase in the segmentation between credit markets after the beginning of the crisis.
  - The CDS market could be more related with systemic risk whereas ASP and bond markets could be more influenced by idiosyncratic risk.

Additional Results: Determinants of DCCs

- We regress the daily DCCs on six groups of potential determinants:
  - *Liquidity*, *Rating*, *Global Risk factor*, *Domestic economic situation*, *CDS and Bond features.*
  - We find that the break in co-movement is explained by liquidity and risk measures.

Conclusion

- Liquidity does affect the price discovery process in credit derivatives markets.
- We make four contributions to the literature:
  1. We offer a theoretical model to test price discovery in credit derivatives markets.
  2. This is the first analysis of price discovery between ASP and CDS markets.
     - The position of ASPs as information providers improves during the crisis.
  3. We obtain that the ASP market is "information dominant" with respect to the bond market.
  4. The correlation between ASP, bond and CDS innovations are estimated from a DCC-GARCH model:
     - The DCCs into the CDS market increase during the crisis.
     - The DCCs into either the ASP or the bond market decrease.
     - The DCCs between the CDS and ASP markets and between the CDS and bond markets decrease.
     - Both liquidity and risk measures are the main explanatory variables of these DCCs.